NAVAL POSTGRADUATE SCHOOL

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THESIS

KNOWLEDGE ENGINEERING CONSIDERATIONS FOR
IMPROVING INFORMATION SHARING IN THE JOINT
IMPROVISED EXPLOSIVE DEVICE DEFEAT TEST
BOARD

by

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June 2011

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Improvised Explosive Devices (IEDs) will continue to evolve as the enemy's weapon of choice. Dynamic and responsive enemies alter IEDs in reaction to our Counter-IED efforts, which results in the need for continuous accelerated testing and acquisition of Counter-IED tools. Over the last five years, an accelerated acquisition process enabled the expansion of testing entities and ranges beyond the purview of the Joint Improvised Explosive Device Defeat Test Board (JTB) established to monitor them. As a result, information sharing between JTB organizations is not efficient, which leads to less capable and slowly fielded equipment. This research reports on the use of a cognitive task analysis and contextual inquiry focused on identifying and mitigating information sharing impediments. The objective is to provide recommendations to improve information sharing between personnel involved with the JTB. Results indicate that the most common information sharing barriers relate to organizational culture, which leads to the recommendation of creating a JTB position specifically focused on information flow inside and outside of the organization. Results regarding information sharing enablers indicated that enhancing test range cooperation and improving information systems through more tester level meetings, use of the customized affinity diagram, and implementing user recommendations would improve information sharing.

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LIST OF ACRONYMS AND ABBREVIATIONS

APG	Aberdeen Proving Grounds
C-IED	Counter Improvised Explosive Device
China Lake	Naval Air Warfare Center Weapons Division China Lake
CTA	Cognitive Task Analysis
DoD	Department of Defense
DoD Strategy	Department of Defense Information Sharing Strategy
IED	Improvised Explosive Device
JIEDDO	Joint Improvised Explosive Device Defeat Organization
JTB	Joint Improvised Explosive Device Defeat Test Board
National Strategy	National Strategy for Information Sharing
NPS	Naval Postgraduate School
PM	Program Manager
Point Mugu	Naval Air Warfare Center Weapons Division Point Mugu
QDR	Quadrennial Defense Review
TSWT	Theater Support Web Tool
YPG	Yuma Proving Grounds

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I. INTRODUCTION

A. ESTABLISHING A FOCUS

1. Background

On February 14, 2006, the Joint Improvised Explosive Device Defeat Organization (JIEDDO) was established. Subcomponents of JIEDDO include multiple boards, one of which is the Joint Improvised Explosive Device Defeat Test Board (JTB). According to Department of Defense Directive 2000.19E, "The JTB coordinates and synchronizes all Joint IED Defeat test and evaluation (T&E) events within the Department of Defense and assists the Military Departments to maximize utility and decrease redundancy in testing of Joint IED Defeat initiatives" (p. 16). Due to the complexity of the environment, structure of the organization, socio-cultural factors, and lack of incentive to share knowledge among test conductors, the JTB is currently not accomplishing its mission as efficiently as possible.

Improvised explosive devices (IEDs) continue to be the enemy's weapon of choice. The dynamic and responsive enemy alters IEDs in reaction to our Counter IED (C-IED) efforts, which results in the need for continuous accelerated testing and acquisition of C-IED tools.

Over the last five years of this accelerated acquisition process, testing entities and ranges have expanded beyond the purview of the JTB. Personnel performing functions in support of the JTB have little incentive to share knowledge. In fact, due to competition for funding sources, in some cases, there is a disincentive to share information among test ranges.

In an effort to improve information sharing within the JTB, the Naval Postgraduate School (NPS) has embarked on a research campaign to conduct thesis research in order to help make the JIEDDO test program more successful. A knowledge engineering effort was conducted with the goal of developing an understanding of the

critical tasks and required information types involved in the C-IED process. The final objective is to improve information sharing between all personnel involved with the JTB. This knowledge engineering effort and a related end-user analysis are the first two in the series of six theses planned as part of this campaign. They may be followed by theses on JTB portal design, a second cognitive task analysis on three-dimensional user interfaces, a C-IED optimization tool, and a three-dimensional JTB portal design.

It is important to understand that there is a difference between the composition JTB, as defined in DoD Directive 2000.19E, and the enterprise of organizations and individuals that process and conduct research and testing to accomplish the stated mission. The scope of this thesis research was limited to information sharing regarding test execution and reporting for the JTB. Interviews were conducted with: (1) individuals within the JTB; (2) members of the advanced communications and foreign release working groups; (3) test directors at Yuma Proving Grounds (YPG), Aberdeen Proving Grounds (APG), and Naval Air Warfare Center Weapons Division China Lake (China Lake); and (4) other subject matter experts with JTB experience. Interview questions focused on what information each individual needed, expected, received, failed to receive, and provided.

This research was required because the lack of information sharing between these entities contributed to duplication of effort, inefficient use of resources, and most importantly, delays in fielding equipment to the war fighter (U.S. Government Accountability Office, 2009). Typically, the JTB would send requirements, prioritization, coordination, and resources, and receive analysis, and reporting from working groups, program managers (PMs), and Joint Program Executive Offices. As of the writing of this thesis, information did not flow as needed for all personnel associated with testing C-IED weapon systems.

2.   Research Questions

In the conduct of this thesis, the researcher focused on two questions. What impediments exist to information sharing within the JTB? How can those impediments be mitigated? Multiple secondary supporting questions were also considered.

II.   BACKGROUND

A.   CONTEXT

The objective of this thesis was to improve information sharing in the JTB organization; the method to achieve that objective was a cognitive engineering analysis. It describes how users decide what information to share and with whom.   Before considering their decision-making process, however, one must have an understanding of the concepts that will be discussed in the following chapters.   This chapter provides a review of information sharing, organizational considerations, and cognitive systems engineering.

B.   INFORMATION SHARING: WHAT IT IS AND WHY PEOPLE DO IT

1.   What It Is

Although information sharing seems like a straightforward concept, it has different connotations that depend on the context of the discussion.   For example, in politics it often refers to interagency coordination, while in the medical field it refers to privacy of individual medical records.   Because this project is focused within the Department of Defense (DoD), the definition and understanding of information sharing will be based on the Department of Defense Information Sharing Strategy (DoD Strategy).   The DoD strategy is based on the National Strategy for Information Sharing (National Strategy) and the 2006 Quadrennial Defense Review (QDR); it is implemented through the DoD Information Sharing Implementation Plan.   The National Strategy is focused on combating terrorism.   The vision is stated, in part, to "establish a more inte-grated information sharing capability to ensure that those who need information to protect our Nation from terrorism will receive it and those who have that information will share it" (National Security Council [NSC], 2007, p. 2).   It does an excellent job of providing guidance to that end; however, the closest that it comes to defining the concept is, "The exchange of information should be the rule, not the exception, in our efforts to combat

the terrorist threat." (NSC, 2007, p. 1) What makes it relevant to this thesis is that it influenced the creation of the DoD Strategy, which broadens the vision and provides a working definition of the concept. The DoD strategy was published in response to the QDR decision to, "Strengthen its data strategy . . . to improve information sharing and information assurance, and extend it across a multitude of domains . . . [and] Develop an information-sharing strategy to guide operations with Federal, state, local and coalition partners." (U.S. Department of Defense [DoD], 2006, p. 59).

The DoD Strategy broadened the vision from terrorism to one that is applicable throughout its area of influence; the stated vision is, "**<u>Deliver the power of information to ensure mission success th</u>   rough an agile enterprise with freedo m of maneuverability across the information environment**" (U.S. Department of Defense [DoD], 2007, p. 3). (Bold text and underlining are included in the original.) The DoD Strategy definition of information sharing, which will be the standard throughout this thesis, is "'**Making information available to participants (people, processes, or systems).'** Information sharing includes the cultural, managerial, and technical behaviors by which one participant leverages information held or created by another participant" (DoD, 2007, p. ii). (The quotation marks and bold text are included in the original document.) It is significant to note that the definition specifies information sharing as a behavior, which means that it cannot be relegated to a task of an information system. The Strategy includes appropriate changes to the culture and approaches to implement, but it does not address what motivates people to share.

2.   Why People Do It

The culture will not change, nor will the approaches be successful if individuals are not motivated to share and if they do decide to share, there is a difference between sharing information and sharing tacit knowledge. Research by Lam and Lambermont-Ford (2010) indicates there are three categories of motivation to share information: intrinsic normative, intrinsic hedonic, and extrinsic. Intrinsic normative motivation is sharing because one feels that it is the right thing to do. In the case of the research topic for this thesis, a member of the JTB organization who is motivated by intrinsic normative

motivation would share information because the person would consider it a job requirement. Intrinsic hedonic motivation involves sharing information because it makes one feel good. In this example, the member feeling intrinsic hedonic motivation would share information because it would make the person feel good that war fighters may benefit from it. Extrinsic motivation is sharing information in return for something of value. The member in this case would share information if it would result in a promotion. What makes motivating an enterprise to improve information sharing is that different members are motivated by different permutations of the categories and the permutation changes for each member changes throughout the day.

To further complicate the situation, the DoD definition specifies sharing of information held or created by another participant. Information held by another can be considered tacit knowledge or an information product. Tacit knowledge, similar to expertise, is understood without being part of a document. Information products, on the other hand, are tangible documents. People view the sharing of these two types of information differently. Essentially, the permutations of the motivational categories are different, so one may share an information product because of intrinsic normative motivation, but require intrinsic hedonic motivation to share tacit knowledge. Another difference between these types of information is the medium used for sharing. Information products are easily shared via information systems. The unwritten nature of tacit knowledge, on the other hand, makes it difficult to document and disseminate. According to research by Constant, Kiesler, and Sproul (1994) and Holste and Fields (2010), tacit knowledge sharing also varies with the level of trust the individual has with his coworkers more than sharing information products. The higher the level of trust, the more tacit knowledge is shared.

C.   ORGANIZATIONAL CONSIDERATIONS: HOW WE ENCOURAGE IT

1.   Organizational Culture

Considering the complexity of different motivations for sharing information, an organization must create a diverse culture in order to stimulate as many members as

possible to participate. The individual stimulation must be generated through an organizational culture that is strong enough and focused enough to influence a member's mindset. Although it is true that "successful information sharing necessitates a mindset where information is continually shared as a normal course of work," (DoD, 2007, p. 5) establishing that mindset requires a strong supportive organizational culture. There are many definitions of organizational culture, and most are founded on an organization's values, beliefs, and norms. For the purpose of this thesis, the value considered is the sharing of information. Beliefs and norms will be addressed through policy and process, respectively.

Beliefs for any organization must be established by an authority figure and disseminated to the members. Because it originates from an authority figure, members accept it as legitimate and a single authoritative source provides the common description of the belief. To put it plainly, "to encourage sharing of work information, organizations need a clear policy." (Constant et al., 1994, p. 418) As the initiation of the implementation of the value to share information, a policy must not only exist, it must provide "clear, concise, and comprehensive guidance" (DoD, 2007, p. 11). Depending on the organizational structure, multiple policies may be required at different levels or knowledge hubs. It is essential that all policies are synchronized to avoid conflicting guidance (DoD, 2007).

The policy must direct members to take specific standardized actions, or norms, though the processes that it directs. While the most important aspect of information sharing is motivating the individuals to participate, the organizational leadership must provide a standard process or set of processes to enable the members to take action and streamline evaluation. As a result, they will be able to take uniform action toward a common goal. In order to be effective, the processes must be created with the user in mind, assigned, enforced, and reviewed for barriers to their purpose.

When creating the new processes, relating them to existing procedures or tasks will ease the transition to the new process. It will also speed the cultural assimilation or "user buy-in" that is necessary to be effective (McLaughlin, 2010).

Just as the policy must be clear and easy to understand, the processes it directs must be assigned to specific member positions for responsibility of compliance and communication (McLaughlin, 2010). Ideally, because the process is related to current practice, compliance should not be much of an issue. However, the assigned individual must have the authority and ability to enforce compliance when necessary. The responsible member must also serve as the point of contact for clarification and suggestions for improvement. Even in the ideal situation presented previously, enforcement is required.

Whether members lack the motivation to share, make errors, or deliberately intend to neglect the policy, the responsible member will need to enforce compliance with the process. The manner of enforcement will depend on the nature of the policy and procedure, lack of compliance, organizational structure, and multiple other variables to be deliberated by the responsible member.

Following implementation, the processes must also be reviewed at regular intervals in order to ensure that they are still applicable and identify barriers to compliance (McLaughlin, 2010). As organizations evolve, their processes must change to maintain applicability to the spirit and/or letter of the policy and evoke the organizational culture. Considering the nature of interaction required for information sharing, if one element of the organization encounters a barrier and fails to participate, the entire organization is affected. By identifying barriers to compliance, they can be addressed and mitigated to the greatest possible extent. Identifying the barriers to sharing and recommending ways to mitigate them is the central focus of this thesis.

2.   Organizational Environment

Once the organizational culture has been established and conditions for motivating members to share information have been developed, the tools for members to conduct the act of sharing must be implemented. Social interaction, incentives, and information systems are the tools that create the organizational environment.

The social interaction aspect of the organizational environment is the most direct means to motivate information sharing. Methods of implementation include exploiting

social networks, increasing interaction, and increasing collaboration. Exploiting social networks essentially puts the power of peer pressure to work. By studying the social networks of an organization, it is possible to identify members who act as sharing hubs within their network, bridges to other social networks, and links to providers (Sun, 2010). Exploiting members in those unofficial positions will create positive effects because people will be comfortable in their roles and fewer new relationships will have to be established than if social networks were ignored.

Something as simple as including greater social interaction can improve the environment. Ironically, as individual communication technology continues to evolve, people spend less time communicating face to face. In light of that trend, research has found that "the best organizational policy may be simply to create occasions for people to talk and exchange knowledge, opinions, and advice" (Constant et al., 1994, p. 419). The organizational environment may be improved, then, by having more meetings, training members on how to conduct meetings more efficiently, and/or increasing participation in large professional gatherings like conventions and symposiums. Sharing tacit knowledge may also increase because McAllister's research (Holste & Fields, 2010) has shown that "higher levels of affiliative behavior (taking a personal interest, passing on information, helping another with tasks) increased affect-based trust among professional peers" (Holste & Fields, 2010, p. 136).

Increasing collaboration among members improves the organizational environment by increasing trust and incorporating social interaction. The ability of an organization to collaborate on a large scale requires a well-established operational environment, but benefits can also be obtained through small scale collaboration exercises. The benefits are greatly based on trust, which, according to McAllister and Dietz (Holste & Fields, 2010), "may be increased through frequent direct engagement of co-workers in collaborative processes—especially situations that illustrate interdependency and provide opportunity for workers to demonstrate individual competency (Holste & Fields, 2010, p. 136). The aspect of direct engagement requires

social interaction. The benefits of physical social interaction have been presented, but the research did not put a physical restraint on direct engagement. Information systems could be incorporated into the collaborative process as well.

Many organizations decide to include incentives in the environment to extrinsically motivate members to share information. In order to be effective, the incentives must fit the type of information to be shared and the tools available (Hansen, Nohria, & Tierney, 1999; Sun, 2010). For example, if the goal of the organization is for the members to share more information products, the incentive should be related to the number of products created or entered into an information system. If the goal is to increase the sharing of tacit knowledge, incentivizing document creation would be ineffective. Rather, the incentive should focus on productive social interaction which results in the passing on of tacit knowledge.

Information systems are often seen as the silver bullet for solving information sharing issues. Although they are a significant aspect of the operational environment and greatly enhance an organization's ability to share information, they are only as good as the members who operate them. When considering including an information system in an operational environment, the planners must consider whether to use a codification or personalization strategy. When studied from the proper perspective, as tools that members use to share information, when appropriately incorporated into the strategy, their contribution falls into one of two categories: social interaction or data manipulation.

While all information sharing strategies are unique, they can be categorized as a codification or personalization strategy. In codification, information is "extracted from the person who developed it, made independent of that person, and reused for various purposes" (Hansen et al., 1999, p. 108). An information system with a large repository to mine for information would be appropriate for this type of strategy. In personalization, on the other hand, the information is largely tacit, so a large repository would not be appropriate. An information system for that strategy would be more effective if it were based on interpersonal communication and included tools for collaboration. Of course all organizations will have some aspects of each category in their strategy, but only one should be followed to ensure unity of effort (Hansen et al., 1999).

The reason for and benefits of social interaction have been covered, but it is not feasible to bring everyone together or send them to conferences. Social interaction can be achieved through an information system with similar effects to physical interaction. The systems can be particularly successful if they incorporate a method to express the need for the information request and feedback to the expert that provides the answer (Constant et al., 1994).

Data manipulation is not different for information systems designed for information sharing than those used for any other reason. However, the ability to disseminate, store, send, receive, and process data regardless of physical location is an essential element of the information sharing environment.

3.   Organizational Structure

The structure of an organization establishes the relationships and authorities of suborganizations. In doing so, it impacts all other elements of information sharing between personnel who are part of the organization. However, because the organizational structure is influenced by many other factors, even if information sharing is a high priority, the strategy must be flexible for proper integration. The organizational structure can create barriers to information sharing, which must be recognized, mitigated, and reviewed as it evolves (McLaughlin, 2010). Therefore, planners must understand both hierarchical and nonhierarchical organizational structures and how information typically flows within them.

Hierarchical organizations separate areas of expertise in order to process information prior to disseminating it to other areas of expertise as input or informing a decision maker, see Figure 1. Processing by areas of expertise ensures accuracy and streamlines information tracking. Sharing information between suborganizations with different areas of expertise is relatively difficult due to both culture and communication equipment connectivity.
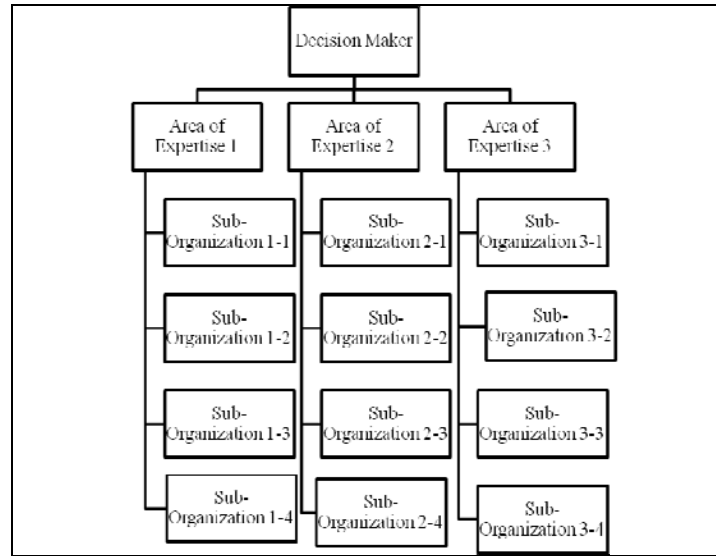
Figure 1.   Example of a Hierarchical Organization

Nonhierarchical organizations integrate areas of expertise into work teams in order to "decentralise authority, share information, diffuse and distribute competency" (Klenke, 2006, p. 231), see Figure 2. Integration of expertise fosters "innovation, product customisation, and technological leverage" (Klenke, 2006, p. 231). Ensuring thorough dissemination of corroborated accurate information to all work teams and consensus building are challenges in this structure due to both culture and communication equipment connectivity. Trust is more significant in nonhierarchical organizations in order for consensus building to be effective.
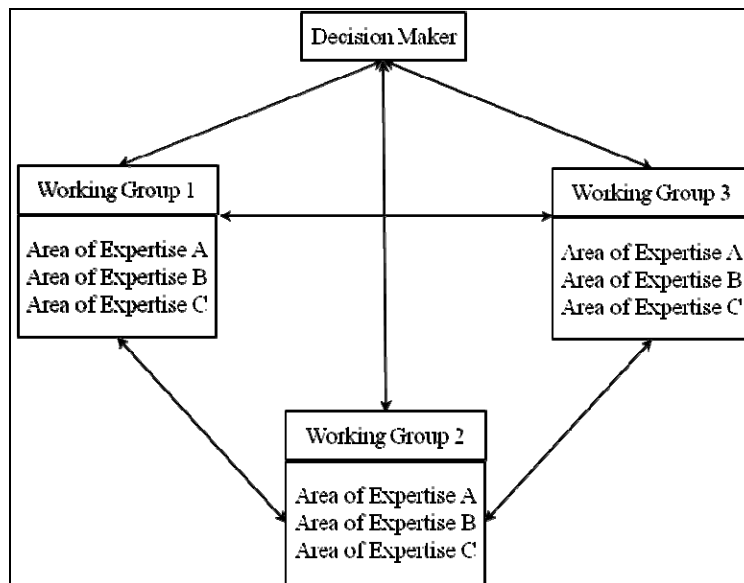
Figure 2.   Example of a Nonhierarchical Organization

D.   COGNITIVE SYSTEMS ENGINEERING: HOW TO FACILITATE IT

1.   Introduction to Cognitive Systems Engineering

Cognitive systems engineering is a process used to design computer systems based on integrating "the fields of human factors, human-computer interaction, cognitive psychology, computer science, artificial intelligence and other related fields" (Introduction, n.d., para. 2).   One of the approaches used for cognitive systems engineering is participatory design, which "places a premium on the active involvement of workplace practitioners...in design and decision-making processes" (Participatory Design, n.d., para. 1). The participatory design methods of cognitive systems engineering integrated for this thesis are critical decision making and contextual inquiry.

2.   Critical Decision Method

The critical decision method is one of several methods used to conduct a cognitive task analysis (CTA). A CTA is used to "analyze and represent the knowledge

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and cognitive activities workers utilize to perform complex tasks in a work domain" (Gordon & Gill, 1997; Schraagen, Chipman, & Shalin, 2000 in Bonaceto & Burns, 2007, p. 40). Critical decision making in particular is a "structured interview technique developed to obtain information about decisions made by practitioners when performing their tasks" (Hutchins, Pirolli, & Card, 2007, p. 290). Essentially, the method elicits a detailed response from the interviewee by asking him to address an extreme atypical situation. By listening to the description and asking additional probing questions, the interviewer attempts to tease out the essential elements of the decision making process. The decision-making processes of the interviewees are analyzed and used to provide input to the systems engineering process.

3. Contextual Inquiry

The goal of contextual inquiry is to "support, extend, and positively transform the work of individuals, teams, and businesses through computer systems" (Holtzblatt & Jones, 1993, p. 177). To reach that goal, it attempts to identify a process for designing systems that support people who engage in similar work in many different business contexts and cultures . . . an expedient process for gathering user information in the time available . . . a means of gaining appropriate and helpful information about users' work. (Holtzblatt & Jones, 1993, p. 177)

The contextual inquiry method is particularly useful because of its structure. It provides a utilitarian balance of theory and practice. It was conceived to be used with other forms of design. The formative principles of context, partnership, and focus, "guide our interaction with users regardless of the specific technique or meeting structure that we employ" (Holtzblatt & Jones, 1993, p. 179). At the same time, it provides the researcher with detailed steps to put the principles into practice through interviews and analysis.

In contrast to the structured interviews of the CTA, contextual inquiry interviews occur while observing and interacting with interviewees while they are conducting routine tasks. Individual or group interviewers monitor interviewees and engage them in conversation throughout the interview. The intent is to observe how the interviewees are

using the tools provided, record their input, and identify barriers that the users themselves overlook. Rather than having a list of structured interview questions, the interviewers arrive with a well thought out focus of the interview. As the interview progresses, the interviewers adjust their focus to interpret the most realistic view possible of the working environment. During the wrap up of the interview, the interviewers confirm that their interpretation is accurate (Holtzblatt & Jones, 1993). Multiple rounds of interviews are often conducted.

Analysis of the interviews is best done by a group but can be done by an individual when appropriate. The product created through contextual inquiry analysis is the affinity diagram. The diagramming process "is a way to synthesize qualitative information into conceptual groupings" (Holtzblatt & Jones, 1993, p. 203). It starts by refining the focus for analysis and reviewing the interview transcripts in that light. During the review process, significant aspects are recorded in detail and capsulated on note paper. After reviewing all transcripts, the pieces of note paper are grouped by how they relate to each other. Analysts shift note papers between groups until they are satisfied that the best relationships are represented. They then name the groups, which become level one of the affinity diagram. The analysts group and name the groups two more times, resulting in a three-level hierarchy of concepts to guide the engineering of the system (Holtzblatt & Jones, 1993).

E.   SUMMARY

1.   Context

The goal of this thesis is to provide an analysis of information sharing within the JTB, which will provide information to inform researchers regarding JTB portal design requirements for the follow on theses in the series. In order to analyze information sharing, one must study the meaning of information sharing, organizational considerations, and relevant methods of cognitive systems engineering that link the human and technological aspects. Studying the meaning of information sharing requires a common definition and understanding of individual motivation to share. Organizational

considerations consist of the organizational culture, environment, and structure. The methods of cognitive systems engineering that are relevant to this thesis are CTA and contextual inquiry. The way these methods were employed will be covered in the following chapter.

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III. METHODOLOGY

A. RESEARCH METHODOLOGY

1. Commencement

The kickoff meeting for this project provided focus, delineated the scope, and recommended the initial research method. The thesis advisors were able to focus the student researchers on the mission of this series of theses by providing an introduction to the JTB organization, its purpose, the current testing process, and the planned contribution of the project.

This introduction necessarily included organizations other than the JTB in order to provide a comprehensive framework that described the entire JIEDDO enterprise for the researchers. Follow-on discussions, however, limited the scope for each of the three initial theses. Limiting the scope was important because it deconflicted the researchers, thus enabling coordination. The scope for this thesis was limited to information sharing regarding test execution and reporting for the JTB. Interviewees included (1) individuals within the JTB; (2) members of the advanced communications and foreign release working groups; and (3) test directors at YPG, APG, and China Lake. Interview questions focused on what information each individual needs, expects, receives, fails to receive, and provides.

This researcher was directed to use the critical decision method of cognitive task analysis. In accordance with the directive, structured interviews were required. Due to the similar scope of the first two theses in the project and practical scheduling and logistical requirements, the researchers planned to conduct joint interviews. This decision was significant because it positively affected the researchers by enabling support during, coordination between, and joint review of the interviews.

B.   PREPARATION

1.   Concurrent Processes

The process of preparing for data collection consisted of the compilation of an Institutional Review Board package, selection of participants, and rehearsals. Planning of all aspects was conducted concurrently by the researchers, advisors, and sponsor representatives in order to streamline the transition from preparation to collection.

2.   Participant Selection

Selection of participants for data collection for both this thesis and the end-user analysis was a coordinated effort between the students, advisors, and sponsor representative. The advisors coordinated the interviews at YPG and Naval Air Warfare Center Weapons Division Point Mugu (Point Mugu), provided some recommendations for other locations, and put the students in touch with the sponsor. Student researchers coordinated the interview at China Lake and provided input to the sponsor regarding the focus of their topics. The sponsor coordinated the interviews at APG and the JTB in Alexandria, Virginia.

Participants were selected based on both their knowledge and experience with JTB testing and availability during the students' limited travel availability due to class schedules. The plan was to include participants with knowledge and experience from different perspectives of the testing process. Perspectives of the testers/processors, support personnel, and facilitators were all relevant and successfully targeted in the selection process. The plan was successfully executed by interviewing. Student travel windows were rigid because of travel planning considerations and concurrent class schedules. The schedule rigidity resulted in the students' inability to interview the Acting Director and Deputy Director, due to a scheduling conflict.

3.   Rehearsals

If one is replicating this process, it is prudent at this point to acknowledge the benefit of realistic rehearsals. This researcher rehearsed by reading through the questions

aloud in order to familiarize himself with the flow and timing of the questions. Such rehearsal prepared him to present the questions in a professional manner; it did not prepare him for handling unfocused or misdirected answers. This resulted in a lack of standardization in analysis because some questions were omitted and others were answered from a perspective irrelevant to the focus of the project. For follow on researchers, regardless of the amount of time available before collection, at least one live, recorded, and timed rehearsal interview with a prepared interviewee is recommended. Even if the interviewee is not an expert in the field, the benefits of operationally checking all equipment, taking notes, addressing interviewee questions, and facilitating the focus of the interview, will improve confidence in oneself and one's questions, the conduct of the actual interviews, and the standardization of the process for more efficient analysis.

C.   INITIAL DATA COLLECTION

1.   Interviews and Surveys

a.   Overview

The initial data collection phase consisted of 11 structured interviews, demographic surveys, and information sharing surveys. The interviews and surveys had the same target audience, addressed in Chapter III.A.1. Both surveys were given to the interviewees and distributed and collected during the interview session. Locations and number of interviews conducted at each location were: YPG (3), China Lake (1), APG (1), JTB (4), Point Mugu (1), and NPS (1). All of the student researcher interviews were conducted jointly with the end-user analysis researcher.

There were two overarching factors that affected the interviews. First, some questions were omitted, at times purposefully, and at other times, erroneously. They were purposely omitted, if they were already answered or clearly not applicable to the interviewee. Others, however, were omitted erroneously by this interviewer. The second issue was that two of the interviews were not recorded. One interviewee did not consent, which was acceptable. The other was not recorded because the interview was

conducted in a secure location where recorders were not allowed. The lack of a transcript greatly reduced the amount of data collected from that interview. Future researchers are advised to ensure that interviews are conducted in an environment where recording is allowed, in order to have that option, should the interviewee consent.

(1) Interviews. The interview format separated the questions into five sections: introduction, orientation, information sharing, information flow policy and procedure, and conclusion. The text of the questions can be found in tables in the results chapter. Only the data collected in the information sharing and information flow policy and procedure sections was used for analysis. The questions addressed organizational culture, environment, and structure, as well as the aspect of participatory design in cognitive engineering.

The information sharing section of the overall set of interview questions consisted of 16 questions that assessed the state of information sharing within the organization, identified barriers, and solicited recommendations for improvement. Organizational culture norms were addressed in Questions 5–11 and 14. The intent of these questions was to document the existing norms for information sharing at multiple levels within the organization. The utility of current information systems was addressed by inquiring about the media used for communication in Questions 6, 8, and 11. Interviewee recommendations solicited in Questions 12, 13, 15, and 16 provided participant data for future design considerations. Questions 1–4 did not address specific motivational or engineering aspects, however, in establishing a dialogue and eliciting a critical decision making situation, they provided an avenue for the interviewee to address the aspects most significant to him.

The information flow policy and procedure section consisted of seven questions that addressed leaders' guidance for sharing information, how information was meant to flow, and how those were reflected in practice. In Question 6, the normative aspect of organizational culture was addressed using information flow; it did not specifically address procedures, which enabled the interviewee to express the actual execution of moving information through the organization. Policy is an element of belief within organizational culture. Question 4 addressed both the existence and

enforcement of an information sharing policy within the JTB. Question 1 addressed the interviewee's perception of the organizational structure relevant to information flow. Participatory design aspects were addressed in Questions 2, 3, 5, and 7.

(2) Surveys. The same demographic and information sharing surveys were given to all interviewees. The demographic survey addressed individual characteristics, education, experience, and placement within the organization.

The information sharing survey consisted of 25 questions broken into three sections: organizational information sharing (12), intra-organization communication structure (5), and organizational culture (8). The information sharing section focused on establishing the norms for the organizations and motivation. All of the questions except number two addressed organizational norms at the personal level. The questions were posed from different perspectives in order to assess not only the quantity and quality of sharing, but the balance of giving and receiving as well. Question 2 addressed motivation. The relatively small amount of attention paid to motivation was intentional. The focus in the initial phase was to collect data on what was or was not being shared, with a lesser focus on how. The why aspect, motivation, would be addressed in the follow-up phase if the initial analysis found a requirement for it.

The intra-organizational communication section also focused on organizational norms, except for a single question on policy. This section differed from the information sharing section by taking a slightly broader perspective and addressing organizational norms within the interviewee's suborganization within the JTB. They assessed the quality, requirement, procedure and process of the current state of information sharing. The policy, or leadership encouragement, was addressed in question number four.

All questions in the organizational culture section addressed norms from the broadest perspective within the scope of this thesis by focusing on information sharing between the JTB suborganizations

b. *Initial Data Collection Summary*

The initial round of data collection consisted of 12 interviews at five organizations, as detailed in Table 1. The general flow of the interviews included introductions, research overview, information sharing interview questions, end-user analysis interview questions, and demographic and information sharing survey completion. Not all interviewees were asked all of the information sharing interview questions, as annotated in the tables presented in the results chapter.

Table 1.   Initial Interviews by Organization

Organization	Number of Interviews
Advanced Communications Working Group	1
Joint Improvised Explosive Device Defeat Test Board	5
Yuma Proving Grounds	3
NAWCWD China Lake	1
NAWCWD Point Mugu	1

D.   INITIAL DATA ANALYSIS

1.   Overview

This section will address the process of analyzing the initial data and how it was used in the follow-up phase of data collection. Results of the analysis will be addressed in Chapter IV. The initial analysis was conducted following the CTA framework. The data was consolidated into narrative that could be further grouped into aspects of the cognitive tasks that could, in turn, be targeted for improvement. These steps are similar to the cognitive inquiry review process, which enabled the blending of the two approaches.

2. Consolidation

Consolidation consisted of transcription of interviews and spreadsheet input for qualitative data. Transcription was a shared effort between the researcher and a professional service. Of the 11 interviews, the researcher transcribed six, three were professionally transcribed, one was not recorded due to security, and the other was not recorded due to lack of consent. The researcher's method of transcription was to listen to the cassette tape, or digital media file multiple times and record what was stated in a Microsoft Word document. The professional transcription service returned the transcripts as Microsoft Word documents as well. For the interviews that were not recorded, the researcher typed his notes into another Microsoft Word document. When the professional transcripts were received, the researcher consolidated all of the documents into a single Microsoft Word document for follow on grouping.

Surveys consisted of responses that yielded data that could be analyzed both qualitatively and quantitatively. Qualitative data was consolidated using the consolidation method for unrecorded interviews described above. Quantitative data was entered into a spreadsheet for statistical analysis.

3. Grouping

Qualitative data was grouped into tables and quantitative data underwent statistical analysis. The qualitative data tables extracted and consolidated the most significant data from the narrative responses from interviews and surveys. The tables were used in the creation of follow-up survey questions and created a pool of notes for use in the creation of an affinity diagram in the consolidated analysis phase. The process of creating the qualitative data tables consisted of integrating the answers to each question, grouping similar responses and identifying trends in the groups. Integrating the answers involved assembling the answers to a question under the text of the question itself. Then, all of the responses were reviewed together, and similar responses were grouped under a single phrase. Here is where the lack of standardization in questioning affected the analysis. Because many of the same questions were omitted in multiple interviews, those lacking answers sometimes outnumbered those with answers, which

reduced their significance. Once the answers were grouped, the groups were reviewed for trends and put into tables, which were used in the follow-up and consolidated analysis.

Quantitative data was run through the descriptive statistics application of the data analysis add-on. The program returned 15 statistics for each question. The most useful statistics for this analysis were the mean, mode, and standard deviation. The statistics will be discussed in the following chapter.

E. FOLLOW-UP METHODOLOGY

1. Method Determination

A second round of interviews to target information gaps found in the initial analysis was expected as a part of both the cognitive task analysis and contextual inquiry methods. The decision to make at this phase was whether to conduct follow-up interviews in person or over the telephone. Telephone interviews were chosen due to the researcher's experience, nature of the questions, funding, and time. Because the researcher experienced multiple work environments during the initial interviews, revisiting them was not deemed necessary. The nature of the questions, based on gaps found in the initial analysis, did not require physical collocation with the interviewee. Funding may have been made available, if travel was necessary. In this case, however, it was decided that travel was not a high enough priority to allocate funds. The amount of time required for both coordination and travel would have taken the researcher from required classes and slowed the production of this document. Telephone interviews were the more efficient in all aspects.

F. FOLLOW-UP PREPARATION

1. Participant Selection

Participants selected for follow-up interviews were either personnel within the JTB or contractors who had supported the JTB. Factors that influenced participant

selection were the number of relevant positions in the organizations and the participant's perspective on information sharing between the organizations. There are fewer positions relevant to this thesis at the ranges than the JTB, due to the nature of the work. At the ranges, the majority of the positions focus on the execution of tests at that location, so the number of people to interview who have experience with sharing information between organizations is limited. The JTB is the opposite. The majority of the positions deal with sharing information with other organizations, both inside and outside of the JTB. The initial round of interviews adequately covered the relevant positions at organizations outside the JTB, so the follow-up interviews were focused on the JTB or contractors with experience at the JTB level. The perspective of information sharing at the JTB level provided more information on sharing between organizations than individuals. Collecting additional data from that perspective was appropriate because it provided clearer focus on the scope of this thesis.

G.   FOLLOW-UP DATA COLLECTION

1.   Follow-Up Interviews

Follow-up interviews consisted of 17 questions divided into five topic areas that addressed organizational culture, organizational environment, and participatory design. See the tables in the results chapter for the text of the questions.

Topic 1, *specific information that needs to be shared*, consisted of four questions. Questions 1.2 and 1.3 addressed motivation, and 1.1 and 1.4 addressed participatory design. The flow of the questions within Topic 1 identifies a specific type of information that needs to be shared and extracts the individual's motivation to share. Asking the interviewee to speculate about why others do not share that information in 1.3 reveals more about his motivation to share. A solicitation for recommendations concludes the topic area.

Topic 2, *information visibility between organizations*, consisted of three questions. Questions 2.1 and 2.2 addressed the personal interaction aspect of the organizational environment, and 2.3 addressed the norms of the organizational culture.

The personal interaction questions targeted the decision making process of finding points of contact in order to gain visibility regarding a piece of information in a JTB suborganization. Whether or not attempting to gain visibility of information outside of the JTB was a norm within the organization was relevant to assess assertiveness within the organizational culture.

Topic 3, *organizational structure,* consisted of four questions. Question 3.0 addressed participatory design and the others addressed the organizational environment. Identifying the customers from the perspective of the participants provides data to system engineers on which organizations or billets to use as a target audience. The remaining questions focused on trust within the organizational environment in order to determine whether or not it should be targeted as an area for improvement. Trust has added significance, due to the JTB being a nonhierarchical organization.

Topic 4, *specific information to be put into a central repository*, consisted of five questions. Questions 4.1 and 4.2 addressed participatory design and 4.3 through 4.5 addressed the organizational environment. The participatory design questions solicited specific data points on what type of information and content should be included in a central repository. The remaining questions dealt with trusting information from that repository. These questions differed from the previous topic area by focusing on information rather than individuals.

Topic 5, *security classification effects on information sharing*, consisted of two questions. Both addressed participatory design. Knowing that changing security classification was beyond the authority of the JTB, the questions solicited the interviewees' view on what barriers were created by security classification and recommendations to mitigate them.

a. Follow-Up Interview Summary

The follow-up round consisted of four telephone interviews. The general flow of the interviews included introductions, research overview, consent form confirmation, survey receipt verification, and interview questions.

2. Follow-Up Surveys

The follow-up surveys were unchanged from the initial round of interviews and were administered to all participants. The same content in the surveys was used for consistency and because the experienced participants would provide quality input. The only change in the survey was the format. Both surveys were altered to have the interviewees fill in form fields rather than fill them in manually. The alterations made it easier to return to the researcher via e-mail. Consent forms and both surveys were e-mailed to all four applicants. All consent forms were signed and returned, but some surveys were not returned. Details are included in the tables in the results chapter.

The difference in the return rate for the initial in person and follow-up e-mailed survey responses was significant. Follow-on researchers are advised to make every effort to administer surveys in person in order to insure a response.

H. FOLLOW-UP ANALYSIS

1. Consolidation and Grouping

The data for the follow-up interviews was consolidated and grouped using the same methodology as the initial interviews. All interview transcriptions were done by the researcher. The interview results were grouped independently of the initial interviews because the questions were different. The initial and follow-up survey results were consolidated because the questions were the same for both rounds of data collection.

I. CONSOLIDATED ANALYSIS

1. Affinity Diagram

The affinity diagram was used to further refine the results of the initial and follow-up phases of interviews into a format specifically designed for cognitive systems engineering. The complete affinity diagram is presented in the results section.

a.   Establish a Focus

The first step in creating the affinity diagram was to establish a focus. The primary focus for this affinity diagram was improving information sharing within the JTB, as defined for this thesis. The researcher posed the following questions to himself throughout the creation process: "What barriers to information sharing exist?"; "How can the barriers be mitigated?"; "What recommendations for improvement were provided by the users?"

b.   Record Key Aspects

With the focus questions in mind, the researcher recorded key aspects from the initial and follow-up analysis phases on a Microsoft Excel spreadsheet. The cognitive task analysis tables created from the interviews and qualitative survey questions in the earlier analysis phases provided the key aspects included in the diagram.

Each key aspect was recorded in a cell on the spreadsheet labeled Tier III. The headers were reorganized and categorized on a spreadsheet labeled Tier II. The Tier II headers were reorganized and categorized on a spreadsheet labeled Tier I. The organization of an example affinity diagram is presented in Figure 3.
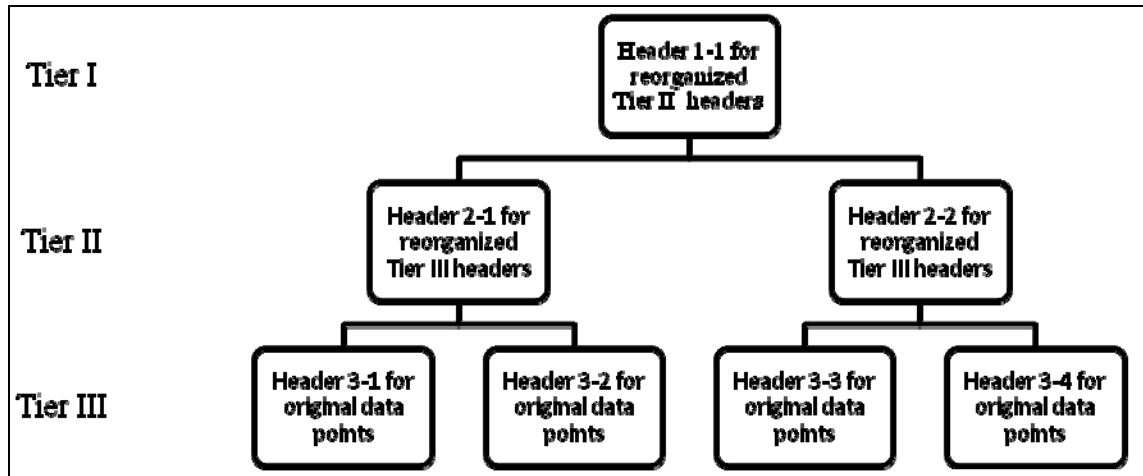
Figure 3.   Example of an Affinity Diagram

Although adhesive notes are the recommended material to create an affinity diagram, the electronic format was more applicable to this situation because it was being recorded by an individual and the results would have to be shared. As an individual, using the electronic format was less cumbersome and more mobile than the adhesive note method. Also, because the final product will be provided to the follow on researcher conducting research on JTB portal design, an electronic format was easier for this researcher to reproduce and the follow-on researcher to manipulate.

c.   Tier III

After all aspects were entered into cells, they were grouped into thirteen columns, and each group was given a heading. The headings represented the main points in each column, as related to the focus. The headings on Tier III were: Personal Relationships, Individual Perceptions, JTB Level Issues, Leadership, Inter-Organizational Communication, Best Practices, Standards, Points of Contact, Personnel Turnover, Quality of Shared Information, Information Sharing Tools, Access to Information, and Information Visibility.

d.   Tier II

The Tier III headings became the key aspects for two further groupings. They were copied and pasted onto another spreadsheet, labeled Tier II. This was done in

order to enhance focus solely on the group headings, make the diagram less cumbersome, and make the final product more organized and readable. The headings were grouped and given their own heading in the same manner as the Tier III aspects. The headings on Tier II were: Individual Issues, Leadership Considerations, Management, Information Sharing, and Information Availability.

e.   Tier I

The Tier II headings were copied and pasted onto a spreadsheet labeled Tier I, in the same manner as previously described. The Tier II headings were then grouped and given another heading. The Tier I headings were the top-level headings for the affinity diagram. The Tier I headings were: Individuals, Leadership, and Information.

f.   Record the Diagram

Recording the diagram was not an issue, due to the use of the electronic format.

2.   Surveys

a.   Qualitative Data

The qualitative data from the initial and follow-up interview question analysis was included in Tier III of the affinity diagram.

b.   Quantitative Data

The quantitative data from the initial and follow-up information sharing survey analysis was consolidated and run through the descriptive statistics application of the data analysis add-on. The program returned 15 statistics for each question. The most useful for this analysis were the mean, mode, and standard deviation. The consolidated statistics will be discussed in the following chapter.

J. SUMMARY

1. Overview

The research methods for cognitive task analysis and contextual inquiry were incorporated for this thesis. Data collection consisted of structured interviews, a demographic survey, and an information sharing survey. Questions were focused on individual motivation, organizational influences, and cognitive engineering. Data analysis included the creation of data tables, in accordance with cognitive task analysis, an affinity diagram, in accordance with contextual inquiry, and statistical analysis.

2. Data Collection

a. *Interviews*

Data collection consisted of structured interviews and surveys. The interviews were conducted in two rounds, initial and follow-up, each with different questions. The initial questions were conducted in person at YPG, China Lake, APG, JTB offices, Point Mugu, and NPS. Follow-up interviews were conducted via telephone with JTB members and contractors with JTB level experience.

b. *Surveys*

Two surveys were administered, a demographic survey, and an information sharing survey. Both were administered in two rounds, initial and follow-up, with the same content, to the same people that were interviewed. The initial round was administered in person and all responses were gathered. The follow-up round was administered via e-mail and multiple responses were not returned.

3. Data Analysis

a. *Qualitative*

The qualitative information from each round of interviews and the qualitative questions from the surveys were used to create tables that grouped the data into cohesive data points that revealed the cognitive nature of the tasks involved. Separate tables were created for each round. Those data points were then consolidated and used as the key aspects in the creation of a three-tier affinity diagram, which will be provided to a follow on researcher conducting research on JTB portal design.

b. *Quantitative*

Quantitative information from surveys from each round was run through statistical analysis software separately. The data was then consolidated and run through the same software. The initial, follow-up, and consolidated statistics will be discussed in the following chapter.

IV. RESULTS

A. OVERVIEW OF RESULTS

1. Presentation of Results

This chapter presents the results of the research. The methodologies used were designed to produce tabular results, which create the majority of the chapter. Text is used minimally to provide context for tabular content or present results that are not suitable for tabular presentation.

2. Consolidated Demographics

The demographic information for the 15 interviewees shows that they are well educated and experienced, especially considering the relatively short existence of the JTB. It also shows the diversity in duties among the members of the organization, which is reflected in the interview results as well. Due to the number of demographic responses that were not appropriate for tabular presentation, the results will be described in the following paragraphs.

The mean age group of the participants was 31 to 40 years old. Fourteen of the 15 participants were male. The education level of the participants ranged from high school to doctorate degree, with the majority of the participants having a bachelor's degree. Seven of 15 had taken a single formal course relative to C-IED testing, and one had taken several related courses.

Twelve of 15 participants had testing experience. The three participants without testing experience were JTB employees not directly involved in testing. Of those with experience, the average length of experience with C-IED testing was 4.8 years. Five participants were in positions directly involved with testing, and 10 were not. The average time in their current position was one to five years, one had less than one year and two had three- to ten-year's experience.

Regarding their place of employment, six were from the JTB, three were involved in testing at YPG, one was from the Advanced Communications working group, one was from China Lake, one was from a program office, and three were not associated with the JTB.

Five of the 15 had worked as members of multiple JTB organizations. One at the JTB had served on the National Assessment Group and as a technical advisor, one from a test range listed another position at the same range, one in the Advanced Communications Working Group had experience at a test range, one at a program office listed another C-IED related program office, and one provided no further details. Of the 15, seven had not participated in any JTB sponsored tests, two participated in less than 10, two participated in between 90 and 100, and four participated in 200 or more tests.

3.   Interview Summary

a.   Initial Interview Summary

The initial interview questions were separated in two sections, reflected in the two tables that follow. The tables include the question number, question text, a summarized analysis of the answers, and the number of responses for each question. Detailed data points from the interviews will be presented in the CTA tables and the affinity diagram later in this chapter.

Table 2 presents responses to the survey questions in the Information Sharing Section, which focused on the individuals' experiences with sharing information.

Table 2.   Initial Interview Information Sharing Section Summary

#	Question Text	Answer Summary	N*
1	From your perspective, what differences exist regarding information needs between the organizations?	Information needs are similar among the test facilities. However, organizations that process and distribute the results have different requirements.	11
2	Please describe a time when you needed to use information from another organization.	All examples ended in receiving the required information. Only one dealt with another organization within the JTB, and that was contingent on a personal relationship.	5

3	Please describe a time when you were asked to share your information with another organization.	Examples included inter-testing facility sharing	5
4	Please describe an exceptionally challenging experience when you successfully or unsuccessfully shared information with the JTB or one of its organizations.	Positive feedback focused on cooperation between test ranges. Negative feedback referred to information visibility and availability, changing requirements, getting raw data from a test facility, and sharing with coalition partners.	10
5	In your experience with JTB tests, to what extent does your organization provide information to other organizations?	Information is provided to others through personal points of contact and by posting it to the JTB portal and Theater Support Web Tool (TSWT). Answers did not explicitly address the extent of providing information.	10
6	When was the last time you or your team provided information to another organization? How did you send that information? Is that typical? What is typical?	Information provision ranged from constantly to semi-annually, with a majority being daily. All means were typical and included personal communication, e-mail, JTB Portal, video teleconference, and telephone.	11
7	In your experience with JTB tests, to what extent does your organization receive information from other organizations?	Information reception ranged from none to 'as it is requested', with a majority being 'as it is requested'. A single response included receiving information without requesting it, and that dealt with budgeting.	11
8	When was the last time you or your team used information received from another organization? How did you receive that information? Is that typical? What is typical?	Timeframes ranged from currently to a couple of months ago. Noted reception methods included e-mail, video teleconference, and the JTB database.	11
9	In your experience, how much of the information you needed from other organizations have you been able to obtain? To the extent that you were unable to obtain all of the information you needed, what was the primary cause of the problem?	Information obtain ability ranged between 'a fair amount' to all of it, with a single exception the replied 'no'. Problems consisted of a lack of timeliness, lack of access to the information, managerial resistance, and reception being based on inconsistent personal relationships because the organization is always changing,	11
10	What are the most significant aspects, positive or negative, of sharing information between JTB organizations?	Positive: ranges working together; sharing once makes it easier the second time; and everything is done for the war fighter. Negative: people don't know who to ask for what type of information; people at different locations do not know each other; and the receiver must understand the information before it should be shared.	6
11	Does your organization share information with other organizations through ad hoc means or means other than those provided through the JTB? If yes, what are they? How well do you think they would work if they were used throughout the JTB and other organizations?	No ad hoc methods were provided. Means provided included working groups, video teleconferences, the JTB Portal, and test protocols.	6

12	Exchanging more information with which other JTB organization would improve your organization's performance (examples if needed: test range, working group, board members)?	The majority of responses did not answer the question, but were addressed in the analysis. Relevant responses were other test ranges, JIEDDO, and JEIDDO modeling and simulation.	11
13	What changes would you make to improve information sharing between all personnel involved in JTB testing?	Recommendations related to the following: a better database, ensuring awareness of available information, ensure the principle players are coordinating with each other, disseminate working group information, and disseminate an up-to-date organizational chart.	11
14	What, if any, impediments to sharing test results are you aware of?	Impediments consisted of: corporate culture, financial competitiveness of the ranges, inability to access other range databases, approval required before information can be released (one location), results from other customer tests are not shared, and foreign release ability	10
15	Please describe any information gaps that exist regarding information sharing and how you would fill them	Four of the eight responses noted the absence of gaps. Others made the following recommendations: create an information czar to manage working group information; make PMS-408 the Joint Counter Radio-Controlled Electronic Warfare Program Manager; and standardize data collection and storage (file formats, etc.).	8
16	Would more sharing of information between organizations help or hinder timely and accurate results? How?	All responded that it would help, but none described how.	2

*Number of responses out of 11

Table 3 presents the results of the participant responses to items in the Policy and Procedure Section, which focused on sharing between organizations and the guidance from the top of the hierarchy.

Table 3.   Initial Interview Policy and Procedure Section Summary

#	Question Text	Answer Summary	N*
1	How does the information that you process or create get to the JTB?	Responses consisted of the following: it depends on the personal relationships involved, directly to the JTB, post to the JTB portal, directly to foreign release officer, post to Theater Support Web Tool (TSWT), send it through a working group	6
2	What specifically enables or inhibits information sharing with the JTB and other organizations?	Culture, personal bias, nothing, lack of visibility on what's been collected, security classification	5
3	What procedural improvements do you recommend to mitigate any inhibitions to information sharing?	Recommendations consisted of the following: bring all C-IED testing under the JTB's purview, current process is good, (oracle) database will help, all data from all locations should flow to a backup site, create standard operating procedure for information sharing, and I don't	10

		know	
4	Is sharing information between organizations and the JTB supported by clear policy and guidance? In your experience, is this policy routinely enforced?	Responses included: guidance is there, guidance is not there, there is a policy, there is probably a policy - but I don't know what it is, there is not policy, and people follow norms rather than written policy	11
5	What policy changes, if any, would you recommend to enhance information sharing between organizations and the JTB?	Recommendations were: have ranges work together on tests, create a database with the ranges and their customers, all JTB members should have to visit the test ranges to establish personal contacts, create turnover binders, and enforce existing policy	10
6	Please explain any uncertainty or confusion regarding information flow into or out of your organization. In your opinion, how can the uncertainty or confusion be mitigated?	Of those who responded that there is uncertainty, it is due to: test ranges have other customers besides the JTB, personnel turnover at JTB requires the establishment of new personal relationships, and people don't know who to go to for what information. Recommendations for mitigation included: process maps for data flow processes, infrastructure, research & development, get employees together to build personal relationships, and creating an information sharing policy	10
7	Please describe what you think would be the most efficient route and method to exchange information between organizations.	Recommendations included: add a pop-up alert for new information on the JTB portal and implement a quality easy to use web interface	3

*Number of responses out of 11

b.   *Follow-Up Interview Summary*

The follow-up interview format was separated into five topics, reflected in the following five tables. Topic one questions addressed specific information that needs to be shared. The questions under this topic were meant to clarify preliminary analysis of the initial survey results, which showed that interviewees were receiving all of the information that they needed, but thought more sharing would be beneficial. While many good data points were raised and included in the CTA and affinity diagram, not all of the specific details that were targeted by the questions were provided.

Table 4.   Follow-Up Interview Summary: Specific Information That Needs to be Shared

Topic 1 - Specific Information that Needs to be Shared			
#	Question Text	Answer Summary	N*
1	What specific type of information needs to be shared?	Most of the responses did not answer the question, but were included in the analysis. The one response that did	4

#	Question Text	Answer Summary	N*
		answer the question recommended that data being collected by the program offices should be shared with the JTB and the field.	
2	Considering your answer to the previous question, why are you not giving that specific information?	Responses were either that the question did not apply because the interviewees were not sharing the information or did not directly answer the questions, but were included in the overall analysis.	4
3	Regarding that same information, why do you think that you are not receiving it?	Suggestions included: a lack of trust, the difficulties involved, the lack of a process, and some people don't perceive a requirement to share	4
4	How can the situation be remedied to ensure people are able to share the right information?	Recommendations included: post information to a single location to ease access, ensure visibility of information, increase coordination, create a better process for sharing, and conduct working groups to integrate the methods of all locations.	4
5	Who are the JTB's customers?	DoD, operating forces, coalition partners	4

*Number of responses out of four

Topic two questions addressed information visibility between organizations. Issues raised during initial interviews included of a reliance on personal relationships for sharing information, problems being able to figure out who to contact to get information, and issues with visibility of who has what information. The visibility issue referred to both within the JTB and outside, including program managers and other range customers. Therefore, questions related to this topic focused on how interviewees used existing points of contact and how they created new contacts in order to discover information that was not readily visible and accessible.

Table 5.   Follow-Up Interview Summary: Information Visibility Between Organizations

Topic 2 - Information Visibility Between Organizations			
#	Question Text	Answer Summary	N*
1	When you need a piece of information, please describe the process you use to decide who to ask for it?	Processes included: use the organizational chart, use the JTB portal to find the information without asking someone, and weekly video teleconferences	4
2	If you have a need for information, but do not have a personal relationship with someone who has it, how do you find out who to contact to get the information you need?	The answers were the same as question 1.	4
3	Understanding that organizations outside of the JTB can have	Three of the four answered yes, while the other answered that it should be taken care of through the contracting	4

proprietary information, if you had reason to believe that someone outside of the JTB, such as a program manager or civilian business, had information that could benefit your organization, would you contact them?	process. Means of finding points of contact consisted of networking through working groups and at conferences, getting them from the chain of command, and calling a business contact number and talking to people within the organization.	

*Number of responses out of four

Topic three questions addressed organizational structure. The JTB does not fit the mold of a hierarchical organization, due to the geographically separated nature of the enterprise, which includes a collection of different services and agencies conducting different, but similar tasks.   As a result, the JTB is partially a flat organization. In order for flat organizations to work, the employees must trust each other and/or the information the other provides. The questions under this topic focused on trust.

Table 6.   Follow-Up Interview Summary: Organizational Structure

Topic 3 - Organizational Structure
#	Question Text	Answer Summary	N*
1	Do you trust the information that you receive, whether or not you have met the person sending it?	The majority said yes, but the others would check the sender's reputation with others in the same field.	4
2	Do you trust other members of the JTB organization enough to share information with them, even if you have never met them face to face?	The overall consensus was yes, if they had a need to know.	4
3	Do you consider other members of the JTB organization experts in their particular fields?	Half would and the other half would want to confirm their credibility before assuming they were experts.	4

*Number of responses out of four

Topic four questions addressed specific information to be put into a central repository. The purpose of this topic was to elicit specifics regarding the content and use of a central repository because the creation of 'a database' was a recurring recommendation by multiple interviewees for many topics in the initial round of interviews.

Table 7.   Follow-Up Interview Summary: Specific Information to be Put Into a
Central Repository

Topic 4 - Specific Information to be Put into a Central Repository			
#	Question Text	Answer Summary	N*
1	What, specifically, should be in a central information repository for the JTB?	Data that is appropriate for wide distribution, including: test plans, test reports, scenario data, conditions/environmental, performance data, and representation of the sensor for instrumentation	4
2	Should the repository consist of both technical and administrative information (scheduling, budgeting, etc)?	Responses were evenly split between making it a one-stop shop for all information and making it a strictly technical store of knowledge	4
3	Do you believe that others would use your information correctly? Why?	All agreed that the information would be used correctly. Some additional information included the need for a defined organization for the information and feedback mechanisms on the JTB portal.	4
4	Do you trust others to use your information? Why?	Three of the four stated yes, and the other noted that it had to be made available and that most people would use it correctly	4
5	Would you trust the information others entered into the central repository? Why?	All agreed that they would trust the information. Access controls provided additional confidence for one responder	4

*Number of Responses out of four

Topic five questions addressed the effects of security classification on information sharing. Multiple initial interview responses stated that security classification inhibited information sharing, so the questions under this topic were meant to provide clarification.

Table 8.   Follow-Up Interview Summary: Security Classification Effects on
Information Sharing

Topic 5 - Security Classification Effects on Information Sharing			
#	Question Text	Answer Summary	N*
1	What makes the security classification of a report an inhibition to information sharing?	Security requirements are there for a reason and must be followed regardless of the situation. If a report is to be shared with a coalition partner, at least two different copies must be processed.	4
2	What are your suggestions to resolve the issue?	If multiple security versions will be required, prepare them simultaneously from the start, rather than editing the finished product	4

*Number of Responses out of four

B.   QUALITATIVE RESULTS

1.   Cognitive Task Analysis

a.   CTA Table Description

This section describes which data points were included in the CTA, how they were organized and presented, and acknowledges the absence of data points in specific areas.   The CTA tables include data points from initial interviews, follow-up interviews, and qualitative answers to survey questions.

The data points were initially organized by whether they identified barriers or enablers to information sharing, or recommendations to improve information sharing. Those data point groupings were then subdivided into the motivational and organizational culture, environment, and structure influences described in the methodology chapter. The result was a collection of twelve tables that organized the data points by cause (the methodology chapter organization), and effect (barrier, enabler, or recommendation).

The data points did not address all subdivisions, so some of the columns have no entries, and are annotated accordingly. Also, three tables had no data points, so they are not included; they were: organizational structure enablers, motivational recommendations, and organizational structure recommendations.

Table 9 presents the motivational barriers based on information collected from participant surveys. It includes participant responses related to intrinsic, intrinsic hedonic, and extrinsic motivation.

Table 9.   Motivational Barriers

Intrinsic	Intrinsic Hedonic	Extrinsic
Meetings that include coalition partners restrict some communications	Maintain organizational reputation by preventing misuse of data by other organizations	Everyone trying to secure funding
People are reserved in large video teleconferences because they are not willing to share with information with all of the participants	Maintain organizational reputation by the provider restricting sharing to only those who he believes understand what to do with the information	Sharing information is helping your competition, which puts your job at risk

	Individuals hoard information to make themselves seem more powerful	Testers and range workers fear losing their jobs
	Individuals don't share in order to avoid being judged by their peers.	
	The belief that the info is mine so no one else can interpret it	
	Individual's fear of data being misused	
	Protect the war fighter by ensuring that information is not taken out of context	

Table 10 presents the organizational culture barriers based on information collected from participant surveys. It includes participant responses related to beliefs and norms. Belief data points dealt with issues related to policy and norm data points dealt with issues related to process.

Table 10.   Organizational Culture Barriers

Beliefs (Relating to Policy)	Norms (Relating to Process)
Managerial resistance to obtaining data from another organization	There is no process in place to share information
Institutionalized financial resource competition between test ranges stops information sharing	Most tests are set up as individual tests to be conducted at a single range.
Test ranges have different priorities than the JTB because they have to work with other customers to obtain additional financial resources	Some organizations attempt to repress certain information if it might be harmful to a system
Rivalries between sites and services create barriers	Lack of visibility on updated documents
Bureaucracy has made the organization ineffective	Inability to locate documents that are known to exist in other organizations
Management is inadequate at multiple levels	Falsely assuming that others have access to the same information
Decisions are made in a risk averse environment	Individuals don't know who has what information
Belief throughout the organization that sharing information may result in losing business to another organization	Obtaining raw unfiltered data from a test range is a challenge
No commonality of a strategic plan between ranges or from higher	Requirements continually change
There is no standard method or format for requesting, collecting, storing, or disseminating data	Information received is not normally timely or accurate, which leads to getting the information through different means
There is are no formal procedures for information sharing	When sharing occurs, the amount of information received is inadequate
The lack of a written Information Sharing policy results in confusion through reliance on a set of unwritten norms that individuals interpret differently	People get the information they need only after working through barriers

No common data schema or data collection formats	
Requirements levied on individuals change frequently	Sometimes an ultimatum is necessary, even if others know the information is required
The corporate culture focuses on individuals gaining power over others	A certain test range will share only complete test reports officially approved for release
The corporate culture does not value information sharing	Much of the information gathered is proprietary and not shared
Individuals don't see themselves as part of an enterprise	There is a lack of access to information from other facilities and ranges
	There is a lack of access to documents that are known to be available to others

Table 11 presents the organizational environment barriers based on information collected from participant surveys. These include participant responses related to personal interaction, information systems, and incentives.

Table 11.   Organizational Environment Barriers

Personal Interaction	Information Systems	Incentive
Sharing is often contingent upon who you know	Theater Support Web Tool is not user friendly	Nothing Noted
People don't know all the individuals and personalities, so they have a difficult time receiving the information they need	The enterprise lacks a good central repository that has all the metadata and the data required to make use of the information	
Some individuals share only what is requested, despite knowing more is required	There are issues with permissions in the information system	
Working group members don't disseminate what they learn with co-workers	Not being able to access other ranges database for information.	
Sharing is based on the 'good ole boy' system		
Individual biases		
Lack of trust throughout the organization		
The reduced number of working groups results in less personal interaction		
High rate of personnel turnover		
Significant turnover in JTB leadership		
Can't figure out who to talk to for certain information		
Information is generally requested from unknown points		

of contact		
People don't know who to ask for what information		
Some individuals don't know there is a necessity to share		

Table 12 presents the organizational structure barriers based on information collected from participant surveys. It includes participant responses related to hierarchical and nonhierarchical organizations.

Table 12.   Organizational Structure Barriers

Hierarchical	Nonhierarchical
Organizational barriers exist between services	JTB organization is constantly changing
Organizations are managed as "stovepipes"	Geographical distribution of JTB organizations challenges information sharing
	The JTB does not have sole authority over is component organizations, which results in a lack of unity of leadership and purpose

Table 13 presents the motivational enablers based on information collected from participant surveys. It includes participant responses related to intrinsic, intrinsic hedonic, and extrinsic motivation.

Table 13.   Motivational Enablers

Intrinsic	Intrinsic Hedonic	Extrinsic
Sharing information to improve everyone's performance. It doesn't matter who takes the credit, as long as the job is done right	Everything is done for the war fighters, and they are appreciative of it	Information required for budgeting is received quickly
Share to clarify information	Everyone has emotional ties to making sure the war fighters are safe	
Share because it is required to get the job done	Individuals will use information in the central repository correctly if their interest is to help the guys overseas.	
Share so everyone can benefit		

Table 14 presents the organizational culture enablers based on information collected from participant surveys. It includes participant responses related to beliefs and norms.

Table 14.   Organizational Culture Enablers

Beliefs (Relating to Policy)	Norms (Relating to Process)
Creating standard operating procedures within departments	Multiple ranges cooperating on a single test
Organizational culture based on reaction to requirements from the war fighter means inherent flexibility	Analysis metrics and test design information are often shared between organizations
Creating an environment that is open to sharing and protects proprietary interests	Sharing information with modeling and simulation may lead to better models and less open air testing
Guidance from higher leadership	Protocols are open to interpretation
Internal review by JIEDDO	Some commonality of requirements between test ranges
The new deputy director's primary goal has been to improve communication	Working Groups
	Most people get the amount of information they need
	Weekly status reports are done and recorded
	Culture is better now than it was two or three years ago

Table 15 presents the organizational environment enablers based on information collected from participant surveys. It includes participant responses related to personal interaction, information systems, and incentives.

Table 15.   Organizational Environment Enablers

Personal Interaction	Information Systems	Incentive
Personal relationships lead to points of contact	Transitioning to a new Oracle database	Nothing Noted
Getting information depends on personal relationships	The JTB is creating a common server environment that will attach people at all locations	
Personal relationships get assets	Establishing a threat database to track threat resources and their status	
Personal relationships get access to information	JTB portal home page designed as a wheel for easy access to all aspects of the organization	

Attending conferences to develop personal relationships and establish points of contact	Read Me files are available for everything on the JTB portal	
Working groups are a good start to communicating between ranges	Access controls on who can post to the JTB portal increase trust in the posted information	
Physical collocation of leadership enables better communication	Points of contact for the Knowledge Integration and Networking Group are on the top of the page of the JTB Portal	
Weekly meetings	High quality hyperlinks from the JTB portal	
Secure Video Teleconference	Test result availability on the Theater Support Web Tool	
Conferences	Redundant posting on the Theater Support Web Tool and JTB Portal	
Physical collocation of testers from multiple ranges	Tying together IT infrastructure	
Face-to-face groups enhance sharing	Theater Support Web Tool	
Sharing establishes relationships that make it easier to share again		
Getting together to solve problems	JTB portal	
	Email (NIPR and SIPR)	
	Telephone	

Table 16 presents the organizational culture recommendations based on information collected from participant surveys. It includes participant responses related to beliefs and norms.

Table 16.   Organizational Culture Recommendations

Beliefs (Relating to Policy)	Norms (Relating to Process)
Change the culture to a single unified team	Restrict access of information to individuals who know what to do with the information so everyone is willing to share
JTB should provide cleaner roles for testing organizations	Make sure everyone is aware of all available resources
Senior Leadership should enact a new management model across all agencies, at all levels of seniority	Working groups should do a better job of letting others know what information they have to share
Create a position to consolidate and distribute information and updates from working groups	Continue to have projects where different test ranges work together
Standardize the file format of the most commonly used test data	Create procedures for information to flow from all locations to a central repository
Formalize the information sharing processes	Establish the processes for coordination
Create a written set of guidance for continuity for	Create process maps for data flow processes,

each position in order to lessen the impact of personnel turnover	infrastructure, and research & development
Create an information sharing policy for the JTB	Data being collected by the program office needs to be shared with the JTB
Develop overarching protocols	
Build trust with JIEDDO modeling and simulation	

Table 17 presents the organizational environment recommendations based on information collected from participant surveys. It includes participant responses related to personal interaction, information systems, and incentives.

Table 17.   Organizational Environment Recommendations

Personal Interaction	Information Systems	Incentive
Reinstate JTB run range worker meetings	The JTB portal should include: climate data, atmospheric conditions, time, space, and position information	Nothing Noted
Create a collective situational awareness for the organization	A central repository should include: scenario data, environmental conditions, performance data, representation of the sensor for instrumentation, test plans, and test reports that constitute every data element or data record	
Get the JTB leadership together to make sure that everyone is on the same page	Create a multi-security-level database that links data within reports at different levels	
JTB employees should visit all of the organizations to understand how they work	Add a selectable pop-up notice within the JTB portal	
Conduct an offsite to give people the chance to get to know each other	An easy to use well implemented web interface	
Publish a complete organizational chart that includes individuals, their expertise, and contact information	Create a common data store between the JTB and JIEDDO	
JTB needs to establish points of contact at each test location that can help to get people the right test data that they need to be sharing	Create a central data repository where everyone collects, shares, and presents data in a similar fashion	
Create and disseminate a point of contact list for each organization	All data in a central repository should be appropriate for wide distribution	
Increase telephone discussions		

2. **Affinity Diagram**

a. *Background*

This section will establish the focus and explain the presentation of the affinity diagram. As stated in the methodology chapter, the primary focus for this affinity diagram was to improve information sharing within the JTB, as defined for this thesis. With that in mind, the secondary integrated and supporting focus was to collect data that could be used by follow-on researchers in the creation of a portal. The three tiers represent different levels of abstraction in order to enable the user to focus on the most pertinent level.

Due to the quantity of data points in Tier III of the diagram, some explanation of how to read the tables is necessary. First, as described in the previous chapter, the diagram is built from the bottom up, so Tier III contains all of the qualitative data points from all interviews and surveys. There are 13 columns in Tier III, which is presented in sections for readability. As a result, the descriptions before each Tier III table refer to column numbers, which represent the original organization of columns from left to right. Column order is significant because the left to right organization was correlated between all three tiers of the diagram. Figure 4 presents a shell of the affinity diagram in order to clarify how the sectioned tables of Tier III incorporate into the diagram as a whole.
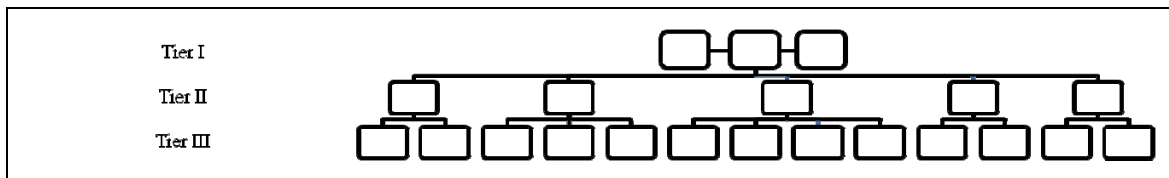

Figure 4.   Shell of the Affinity Diagram

b. *Affinity Diagram Results*

The results of the affinity diagram are presented in the tables that follow. Table 18 presents the first and second columns of Tier III. The table presents considerations relevant to personal relationships and individual perceptions in the design of an information system for the JTB.

Table 18.   Tier III Diagram: Personal Relationships and Individual Perceptions

Personal Relationships	Individual Perceptions
The corporate culture focuses on individuals gaining power over others	Individuals don't see themselves as part of an enterprise
Sharing is often contingent upon who you know	Belief throughout the organization that sharing information may result in losing business to another organization
Personal relationships lead to points of contact	Maintain organizational reputation by the provider restricting sharing to only those who he believes understand what to do with the information
Individuals hoard information to make themselves seem more powerful	Sharing information is helping your competition, which puts your job at risk
Personal relationships get assets	Testers and range workers fear losing their jobs
Sharing is based on the 'good ole boy' system	Maintain organizational reputation by preventing misuse of data by other organizations
Personal relationships get access to information	Lack of trust throughout the organization
People don't know all the individuals and personalities, so they have a difficult time receiving the information they need	Individuals don't share in order to avoid being judged by their peers.
Getting information depends on personal relationships	Share because it is required to get the job done
Individual biases	Share to clarify information
Information is generally requested from unknown points of contact	The belief that the info is mine so no one else can interpret it
Sometimes an ultimatum is necessary, even if others know the information is required	Individuals will use information in the central repository correctly if their interest is to help the guys overseas.
Some individuals share only what is requested, despite knowing more is required	Sharing information to improve everyone's performance. It doesn't matter who takes the credit, as long as the job is done right
Everyone trying to secure funding	Share so everyone can benefit
Attending conferences to develop personal relationships and establish points of contact	Individual's fear of data being misused
Conferences	Everything is done for the war fighters, and they are appreciative of it
Working group networking	Everyone has emotional ties to making sure the war fighters are safe
Conduct an offsite to give people the chance to get to know each other	Protect the war fighter by ensuring that information is not taken out of context
Points of contact for the Knowledge Integration and	

JTB Level Issues	Leadership
Networking Group are on the top of the page of the JTB Portal	
Sharing establishes relationships that make it easier to share again	

Table 19 presents the third and fourth columns of Tier III. The table presents considerations relevant to JTB level issues and leadership in the design of an information system for the JTB.

Table 19.   Tier III Diagram: JTB Level Issues and Leadership

JTB Level Issues	Leadership
Organizational culture based on reaction to requirements from the war fighter means inherent flexibility	The corporate culture does not value information sharing
The JTB does not have sole authority over its component organizations, which results in a lack of unity of leadership and purpose	Culture is better now than it was two or three years ago
Institutionalized financial resource competition between test ranges stops information sharing	Change the culture to a single unified team
Physical collocation of leadership enables better communication	The new deputy director's primary goal has been to improve communication
Most tests are set up as individual tests to be conducted at a single range.	Senior leadership should enact a new management model across all agencies, at all levels of seniority
Create a position to consolidate and distribute information and updates from working groups	Management is inadequate at multiple levels
Bureaucracy has made the organization ineffective	A certain test range will share only complete test reports officially approved for release
Organizations are managed as "stovepipes"	Managerial resistance to obtaining data from another organization
JTB organization is constantly changing	JTB should provide cleaner roles for testing organizations
The reduced number of working groups results in less personal interaction	Requirements continually change
Geographical distribution of JTB organizations challenges information sharing	Requirements levied on individuals change frequently
	Management intervention is often necessary to require others to share information
	Some individuals don't perceive a necessity to share
	Create a collective situational awareness for the organization
	Get the JTB leadership together to make sure that everyone is on the same page
	Creating an environment that is open to sharing and protects proprietary interests
	Decisions are made in a risk averse environment
	Guidance from higher leadership

Table 20 presents the fifth and sixth columns of Tier III. The table presents considerations relevant to inter-organizational communications and best practices for information sharing in the design of an information system for the JTB.

Table 20.   Tier III Diagram: Inter-Organizational Communication and Best Practices

Inter-Organizational Communication	Best Practices
Reinstate JTB run range worker meetings	Continue to have projects where different test ranges work together
Data being collected by the program office needs to be shared with the JTB	Physical collocation of testers from multiple ranges
Organizational barriers exist between services	Multiple ranges cooperating on a single test
Rivalries between sites and services create barriers	Weekly status reports are done and recorded
Sharing information with modeling and simulation may lead to better models and less open air testing	Analysis metrics and test design information are often shared between organizations
Build trust with JIEDDO modeling and simulation	Face-to-face groups enhance sharing
Internal review by JIEDDO	Getting together to solve problems
JTB employees should visit all of the organizations to understand how they work	Working groups are a good start to communicating between ranges
Test ranges have different priorities than the JTB because they have to work with other customers to obtain additional financial resources	Weekly SVTCs
	Increase use of the telephone for discussions

Table 21 presents the seventh and eighth columns of Tier III. The table presents considerations relevant to standards and points of contact in the design of an information system for the JTB.

Table 21.   Tier III Diagram: Standards and Points of Contact

Standards	Points of Contact
No commonality of a strategic plan between ranges or from higher headquarters	People don't know who to ask for what information
The lack of a written Information Sharing policy results in confusion through reliance on a set of unwritten norms that individuals interpret differently	Can't figure out who to talk to for certain information
Create an information sharing policy for the JTB	Publish a complete organizational chart that includes individuals, their expertise, and contact information
Create process maps for data flow processes, infrastructure, and research & development	Create and disseminate a point of contact list for each organization
Formalize the information sharing processes	JTB needs to establish points of contact at each test

	location that can help to get people the right test data that they need to be sharing
Establish the processes for coordination	
There is no process in place to share information	
Create procedures for information to flow from all locations to a central repository	
Creating standard operating procedures within departments	
There are no formal procedures for information sharing	
No common data schema or data collection formats	
Develop overarching protocols	
Protocols are open to interpretation	
Some commonality of requirements between test ranges	
There is no standard method or format for requesting, collecting, storing, or disseminating data	
Standardize the file format of the most commonly used test data	

Table 22 presents the ninth and tenth columns of Tier III. The table presents considerations relevant to personnel turnover and the quality of shared information in the design of an information system for the JTB.

Table 22.   Tier III Diagram: Personnel Turnover and Quality of Shared Information

Personnel Turnover	Quality of Shared Information
High rate of personnel turnover	Information received is not normally timely or accurate, which leads to getting the information through different means
Significant turnover in JTB leadership	When sharing occurs, the amount of information received is inadequate
Create a written set of guidance for continuity for each position in order to lessen the impact of personnel turnover	Information required for budgeting is received quickly

Table 23 presents the eleventh column of Tier III. The column was split into two for readability. The table presents considerations relevant to information sharing tools in the design of an information system for the JTB.

Table 23.   Tier III Diagram: Information Sharing Tools

Information Sharing Tools	
The JTB is creating a common server environment that will attach people at all locations	Create a common data store between the JTB and JIEDDO
Tying together IT infrastructure	Create a multi-security-level database that links data within reports at different levels
JTB portal home page designed as a wheel for easy access to all aspects of the organization	Create a central data repository where everyone collects, shares, and presents data in a similar fashion
Access controls on who can post to the JTB portal increase trust in the posted information	A central repository should include: scenario data, environmental conditions, performance data, representation of the sensor for instrumentation, test plans, and test reports that constitute every data element or data record
High quality hyperlinks from the JTB portal	The enterprise lacks a good central repository that has all the metadata and the data required to make use of the information
Read Me files are available for everything on the JTB portal	Establishing a threat database to track threat resources and their status
JTB portal	An easy to use well implemented web interface
The JTB portal should include: climate data, atmospheric conditions, time, space, and position information	Weekly meetings
Add a selectable pop-up notice within the JTB portal	Theater Support Web Tool
Theater Support Web Tool is not user friendly	Creation of a database
Transitioning to a new Oracle database	Secure Video Teleconference
There are issues with permissions in the information system	Email (NIPR and SIPR)
Redundant posting on the Theater Support Web Tool and JTB Portal	SIPR
Test result availability on the Theater Support Web Tool	Telephone

Table 24 presents the twelfth and thirteenth columns of Tier III. The table presents considerations relevant to access to information and information visibility in the design of an information system for the JTB.

Table 24.   Tier III Diagram: Access to Information and Information Visibility

Access to Information	Information Visibility
Most people get the amount of information they need	Individuals don't know who has what information
People get the information they need only after working through barriers	Make sure everyone is aware of all available resources
There is a lack of access to information from other	Lack of visibility on updated documents

facilities and ranges	
There is a lack of access to documents that are known to be available to others	Falsely assuming that others have access to the same information
Not being able to access other ranges database for information.	Working groups should do a better job of letting others know what information they have to share
Obtaining raw unfiltered data from a test range is a challenge	Working group members don't disseminate what they learn with co-workers
Restrict access to information to individuals who know what to do with the information so everyone is willing to share	Inability to locate documents that are known to exist in other organizations
People are reserved in large video teleconferences because they are not willing to share with information with all of the participants	
Meetings that include coalition partners restrict some communications	
Some organizations attempt to repress certain information if it might be harmful to a system	
Much of the information gathered is proprietary and not shared	

Table 25 presents the complete Tier II diagram. The table presents the information at a higher level of abstraction by categorizing the Tier III column headings.

Table 25.   Tier II Diagram: Individual Issues, Leadership Considerations, Management, Information Sharing, and Information Availability

Individual Issues	Leadership Considerations	Management	Information Sharing	Information Availability
Personal Relationships	JTB Level Issues	Best Practices	Quality of Shared Information	Access to Information
Individual Perceptions	Leadership	Standards	Information Sharing Tools	Information Visibility
	Inter-Organizational Communication	Points of Contact		
		Personnel Turnover		

Table 26 presents the complete Tier I diagram. The table presents the information at the highest level of abstraction by categorizing the Tier II column headings.

Table 26.   Tier I Diagram: Individuals, Leadership, and Information

Individuals	Leadership	Information
Individual Issues	Leadership Considerations	Information Sharing
	Management	Information Availability

C.   QUANTITATIVE RESULTS

1.   Consolidated Information Sharing Survey Results

The quantitative data from the initial and follow-up information sharing survey analysis was consolidated and run through the descriptive statistics application of the data analysis add-on.   The results are presented in Table 27.   The program returned 15 statistics for each question.   The most useful statistics for this analysis were the mean, mode, and standard deviation.   Presenting all of the survey Likert responses for each question was not conducive to a single summary table.   Therefore, the complete information sharing survey text and Likert responses are included in the Appendix.

Table 27. Consolidated Information Sharing Survey Results

#	Question Text	Summary*	N	Mean	Mode**	Standard Deviation
	Organizational Information Sharing Section					
1	How often do you collaborate or share information with other organizations?	Daily	12	1.33	1	0.78
2	The main reason you share information with other organizations is:	I want to	12	3.50	4	1.24
3	In your experience with JTB testing, how adequate has information sharing been between JTB organizations?	Adequate	12	3.67	3	0.78
4	To what extent do organizations provide relevant information to other organizations in a pro-active way, without the other having to ask for it?	Occasionally	12	2.67	3	1.23
5	My organization's mission performance depends on receiving accurate information from other organizations.	Somewhat Agree	12	3.92	5	1.83
6	My organization often obtains information from other JTB organizations required to complete the mission.	Somewhat Agree	12	3.67	5	1.92
7	My organization can depend on information from other organizations.	Neutral	12	3.42	4	1.56
8	Requests for information outside of my organization are answered in a timely manner.	Often	12	3.58	4	1.44
9	To what extent has information you received from other organizations facilitated performance of your tasks?	Often	12	3.58	4	1.38
10	When you obtained information from other JTB organizations the information was: Necessary	Rarely	12	2.33	3	1.44
10	When you obtained information from other JTB organizations the information was: Complete	Rarely	12	1.92	3	1.24
10	When you obtained information from other JTB organizations the information was: Accurate	Rarely	12	2.00	0	1.60
10	When you obtained information from other JTB organizations the information was: Clear	Rarely	12	1.83	2	1.19
10	When you obtained information from other JTB organizations the information was: Trusted	Rarely	12	1.83	0	1.47
10	When you obtained information from other JTB organizations the information was: Timely	Rarely	12	2.00	3	1.28
11	In your experience with the JTB, to what extent are you able to get the information you need from other organizations?	Included in qualitative analysis				
12	I find trying to share information with other organizations and the JTB unnecessarily complex.	Occasionally	12	3.17	4	1.34
	Intra-organization Communication Structure Section					
1	To what extent do you observe problems caused by inadequate communication between the JTB and its organizations?	Occasionally	12	3.00	3	1.13
2	The JTB information flow process allows organizations to share information adequately and in a timely manner.	Neutral	12	2.83	4	1.47
3	My organization's role in the testing process is designed in such a way that we need to interact with other organizations in order to perform our mission effectively.	Somewhat Agree	12	3.83	5	1.99
4	My organization's policies encourage sharing information with other organizations.	Somewhat Agree	12	3.92	5	1.73
5	The information flow procedures between the JTB and its organizations are clearly defined.	Neutral	12	3.08	4	1.44
	Organizational Culture Section					
1	My organization shares ideas openly with other organizations.	Somewhat Agree	12	3.58	5	1.83
2	Other organizations can only successfully complete their mission tasks if they receive information from my organization.	Somewhat Agree	12	4.08	4	1.38
3	Other organizations often need to obtain information from my organization to complete their mission.	Somewhat Agree	12	4.17	5	1.40
4	My organization responds to requests for information from other organizations in a timely manner.	Often	12	4.00	5	1.54
5	The information gathered at my organization is unique, so no other organization would find it useful.	Somewhat Disagree	12	1.67	1	1.37
6	Time spent sharing and reviewing information with other organizations could be spent more efficiently.	Neutral	12	3.08	4	1.51
7	How often is information from current tests kept within your organization in order to compete for future test contracts?	Never	12	1.25	0	1.82
8	How is the intent of keeping this information for future competition communicated?	Explicitly	12	1.75	0	1.91

*Summary indicated here is the mean rounded to the nearest whole number Likert response.

**0 represents the lack of a response. Likert responses that are represented by the other numbers in the column can be referenced in the Appendix.

D. CONCLUSION

1. Return to the Purpose

The CTA and affinity diagram in this chapter used the same data points organized in a different manner for different purposes. The CTA presented reasons why people within this organization made the cognitive decision whether or not to share information. The affinity diagram presented the same data in a format more conducive to engineering a computer system to support information sharing that is customized for this organization.

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V.   CONCLUSIONS

A.   OVERVIEW

This chapter presents conclusions based on the CTA and affinity diagram and provides recommendations for improving information sharing within the JTB and future research.

B.   CTA CONCLUSIONS

1.   Barriers to Information Sharing

Barriers to information sharing were recognized in the categories of motivation, organizational culture, organizational environment, and organizational structure. The type of motivation most often recognized for causing a barrier was intrinsic hedonic motivation. Individuals were motivated to not share their information in order to make them feel better. The feelings were often in regard to maintaining a reputation, attaining power over others, or protecting the purity of their information.

Organizational culture barriers were individually and collectively the most common data points out of all categories in the CTA. While the number of data points is not necessarily as relevant as their substance, it is significant that this category received so much attention by the participants. In the creation of the CTA tables, beliefs regarding sharing information related to policy or higher headquarters issues and norms were process and procedural issues. Individuals did not share information because the organization did not have the formalized policy, process, or procedures in place to create a culture that encouraged sharing.

Participants recognized factors related to personal interaction as the most significant cause of barriers regarding the organizational environment. Few data points related to information systems, and none related to incentives. Personal interaction issues centered on the participants not sharing information or not being able to access information due to the lack of personal points of contact in other parts of the

organization. It is interesting to note that there is the same number of data points recognizing personal interaction as an enabler to information sharing, but for different reasons, which will be discussed in that section. Noting relatively few data points that categorize information systems as a barrier to sharing information is also significant when considering what aspects of the organization to fix or enhance to improve information sharing. The lack of data points related to incentives will be addressed in the future research section.

The nonhierarchical aspect of organizational structure contained more data points than the hierarchical aspect. Issues centered on the dynamic and dispersed structure and the JTB's lack of authority to control its suborganizations, which results in each suborganization being managed as a separate "stovepipe."

2.   Enablers for Information Sharing

Enablers for information sharing were recognized in the categories of motivation, organizational culture, and organizational environment. No enablers were recognized relative to organizational structure. Intrinsic and intrinsic hedonic motivations were essentially equal influences for enabling information sharing. Participants made the decision to share information because they felt it was the right thing to do and/or because it made them feel good that they were helping the war fighters.

Both norms and beliefs were recognized as organizational culture enablers. Norms related to cooperation between ranges as well as between ranges and organizations that conduct modeling and simulation. Beliefs recognized an increasing leadership focus on information sharing.

Organizational environment enablers were related to information systems and personal interaction. As with the barrier section, no data points were noted under incentives. Information systems data points mostly related to the JTB portal and provide a good source of feedback for developers and considerations for future improvements. Participants also recognized the importance of e-mail and the telephone, which ties in the personal interaction aspect. While personal interaction was recognized as a barrier due to personal points of contact, once those points of contact are made they are recognized as

enablers. Another aspect of personal interaction recognized as an enabler was the opportunity to communicate face to face, whether to create points of contact or exchange information between existing relationships.

3. Participant Recommendations for Improvement

Participant recommendations for improving information sharing were recognized in the categories of organizational culture and organizational environment. No recommendations were noted regarding motivation or organizational structure. Both beliefs and norms were recognized by organizational culture recommendations. Recommendations for beliefs centered on improving leadership and increasing standardization. Norms mostly dealt with different aspects of dissemination, to include improving processes, procedures, and visibility.

Organizational environment recommendations were shared between personal interaction and information systems; again, incentives were not noted. Personal interaction recommendations focused on meeting in person and dissemination of a complete organizational chart with amplifying information.

Information system recommendations included some specific types of information to be included in a central repository of information, as well as improvements for the current JTB portal.

C. AFFINITY DIAGRAM CONCLUSIONS

1. Levels of Abstraction

The information contained in the affinity diagram provides a tool for planners and designers to use if JTB leadership decides that designing an information system is appropriate and feasible to improve information sharing. It focuses on feedback to planners and designers rather than understanding why members of the organization decide whether or not to share. As such, it is a good companion method to the CTA, but leads to less telling conclusions. As a tool for planners and designers, the three tiers of the affinity diagram essentially represent three levels of abstraction of the data that can be

used to customize the design of an information system to improve information sharing within the JTB. Tier I, the highest level of abstraction, identifies the issues that need to be addressed. Tier II, the middle level, guides planners in deciding what areas to focus on when developing requirements, an aspect of great importance prior to development. Tier III gets into the weeds and provides details and recommendations useful to planners and designers. It must be recognized, however, that not all data points included in Tier III are feasible or within the control of the organization.

2. Affinity Diagram Conclusions

Tier II is the most appropriate tier to examine when considering conclusions. It identifies individual issues, leadership considerations, management, information sharing, and information availability as focus areas. When considering how designing an information system can improve information sharing, leaders and planners must home in on what aspects technology can feasibly address. For example, it would not be feasible to focus the time, effort, and resources necessary to directly target individual perception. However, by targeting other focus areas, individual perception may be influenced. Narrowing the focus to targeting relevant data points under management, information sharing, and information availability would be a good starting point. Planners should also consider feasible data points from other categories and how changes in the targeted data points may also indirectly address other categories and data points. Once a plan is being created, pulling data points from Tier III will provide amplification and clarity.

D. INFORMATION SHARING SURVEY CONCLUSIONS

1. Organizational Information Sharing

The organizational information sharing section results presented the level of information sharing efficiency between organizations. Although the average participant collaborated daily and the received information often facilitated task performance, the information was rarely complete, accurate, clear, or trusted.

2. Intra-Organization Communication Structure

The intra-organizational communication structure section results presented each participants' evaluation of how well information flows within their organization. The majority of participants perceived the need to interact and responded that their organization's policies encouraged information sharing.

3. Organizational Culture

The organizational culture section results presented each participant's evaluation of the organizational culture. The majority perceived the necessity of giving and receiving information and responded that theirs shares openly.

E. RECOMMENDATIONS

1. Overall

CTA provides focus areas for leadership to address when considering how to increase the likelihood of members sharing information. The information sharing survey enables the participants to evaluate multiple aspects of information sharing between and within organizations. The affinity diagram is a tool that provides a starting point for designing an information system that enables the members to share information by enhancing what they have identified as the strengths and improving what they have identified as the weaknesses.

2. CTA Recommendations

This section presents the author's recommendations to address the most common barriers to and enablers of information sharing within the JTB. User recommendations presented earlier in this chapter should be considered when implementing and changes relative to information sharing.

The most common barriers were organizational culture, both beliefs and norms, and personal interaction. In order to mitigate those barriers, the researcher recommends

that the JTB create a position to focus specifically on information flow both within and outside of the organization. The position would initially be concerned with improving information sharing by recognizing and mitigating barriers by being a 'go to' person for information dissemination and access issues.

Areas recognized as enablers that should be enhanced include the organizational culture norm of cooperation between test ranges and the information systems aspect of the organizational environment. To enhance cooperation between ranges, this researcher recommends increasing meetings between testers from different ranges. Including the actual testers is significant because they are the people who generate the information that everyone else will share. If they create a culture that includes sharing, it will influence the motivation of others and the norms of the organization. Also, the positive image of information systems by the participants leads to the recommendation to enhance the capability of information systems to share information. Investing in JTB portal improvement and including some of the user recommendations would increase sharing capability and let the members of the organization know that their leadership values their input.

3. Affinity Diagram

Information sharing within the JTB would improve if JTB leadership provided a system that could enhance building personal relationships and standardize the information sharing process in order to improve its quality and timeliness, while improving information visibility and access. Whether or not that is feasible is up to the JTB leadership. A recommendation more applicable at this point in the evolving status of the JTB is that any improvements to information systems within the JTB should at least include a review of the affinity diagram because it is customized for the JTB. Other organizations can reference the diagram as an example of how to customize their information technology strengths and weaknesses.

### 4.	Information Sharing Survey

Results from the information sharing survey reinforce the recommendation to create a position to focus specifically on information flow both within and outside of the organization. Individuals collaborate daily, perceive the need, and perceive information sharing positively. Having an individual focus on making the information flow more efficient would improve both organizational culture and performance.

### 5.	Future Research

Future research on incentivizing information sharing for JTB members may prove useful. None of the participants provided data points that related to incentives and there were few data points related to extrinsic motivation, but that was likely due to the focus of this research being to identify barriers and mitigate them. Because there is no incentive system, it is not a barrier, but follow-on research could focus on incentive systems for government employees and contractors. While intrinsic and intrinsic hedonic motivations are powerful, there is always a point where some extrinsic motivation can make the difference between deciding whether or not to share.

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APPENDIX. INFORMATION SHARING SURVEY TEXT

The text of the information sharing survey distributed to all participants is presented below. It provides clarification on the statistical mean column of the Consolidated Information Sharing Survey Results table presented in Chapter IV.

Organizational Information Sharing

1. How often do you collaborate or share information with other organizations?

0	1	2	3	4
No Response	Daily	Weekly	Monthly	Quarterly

2. The main reason you share information with other organizations is:

0	1	2	3	4
No Response	I don't	I was directed to	Everyone else does	I want to

3. In your experience with JTB testing, how adequate has information sharing been between JTB organizations?

0	1	2	3	4	5
No Response	No information has been shared	Too much information sharing	Inadequate	Adequate	Excellent

4. To what extent do organizations provide relevant information to other organizations in a pro-active way, without the other having to ask for it?

0	1	2	3	4	5
No Response	Never	Rarely	Occasionally	Often	Always

5. My organization's mission performance depends on receiving accurate information from other organizations.

0	1	2	3	4	5
No Response	Strongly disagree	Somewhat disagree	Neutral	Somewhat Agree	Strongly Agree

6. My organization often obtains information from other JTB organizations required to complete the mission.

0	1	2	3	4	5
No Response	Strongly disagree	Somewhat disagree	Neutral	Somewhat Agree	Strongly Agree

7. My organization can depend on information from other organizations.

0	1	2	3	4	5
No Response	Strongly disagree	Somewhat disagree	Neutral	Somewhat Agree	Strongly Agree

8. Requests for information outside of my organization are answered in a timely manner.

0	1	2	3	4	5
No Response	Never	Rarely	Occasionally	Often	Always

9. To what extent has information you received from other organizations facilitated performance of your tasks?

0	1	2	3	4	5
No Response	Never	Rarely	Occasionally	Often	Always

10. When you obtained information from other JTB organizations the information was:

Necessary:

0	1	2	3	4
No Response	Never	Rarely	Always	N/A

Complete:

0	1	2	3	4
No Response	Never	Rarely	Always	N/A

Accurate:

0	1	2	3	4
No Response	Never	Rarely	Always	N/A

Clear:

0	1	2	3	4
No Response	Never	Rarely	Always	N/A

Trusted:

0	1	2	3	4
No Response	Never	Rarely	Always	N/A

Timely:

0	1	2	3	4
No Response	Never	Rarely	Always	N/A

11. In your experience with the JTB, to what extent are you able to get the information you need from other organizations?   Results were integrated with other qualitative data from the initial round of data collection.

12. I find trying to share information with other organizations and the JTB unnecessarily complex.

0	1	2	3	4	5
No Response	Never	Rarely	Occasionally	Often	Always

Intra-organization Communications Structure

1. To what extent do you observe problems caused by inadequate communication between the JTB and its organizations?

0	1	2	3	4	5
No Response	Never	Rarely	Occasionally	Often	Always

2. The JTB information flow process allows organizations to share information adequately and in a timely manner.

0	1	2	3	4	5
No Response	Strongly Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Strongly Agree

3. My organization's role in the testing process is designed in such a way that we need to interact with other organizations in order to perform our mission effectively.

0	1	2	3	4	5
No Response	Strongly Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Strongly Agree

4. My organization's policies encourage sharing information with other organizations.

0	1	2	3	4	5
No Response	Strongly Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Strongly Agree

5. The information flow procedures between the JTB and its organizations are clearly defined.

0	1	2	3	4	5
No Response	Strongly Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Strongly Agree

Organizational Culture

1. My organization shares ideas openly with other organizations.

0	1	2	3	4	5
No Response	Strongly Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Strongly Agree

2. Other organizations can only successfully complete their mission tasks if they receive information from my organization.

0	1	2	3	4	5
No Response	Strongly Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Strongly Agree

3. Other organizations often need to obtain information from my organization to complete their mission.

0	1	2	3	4	5
No Response	Strongly Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Strongly Agree

4. My organization responds to requests for information from other organizations in a timely manner.

0	1	2	3	4	5
No Response	Never	Rarely	Occasionally	Often	Always

5. The information gathered at my organization is unique, so no other organization would find it useful.

0	1	2	3	4	5
No Response	Strongly Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Strongly Agree

6. Time spent sharing and reviewing information with other organizations could be spent more efficiently.

0	1	2	3	4	5
No Response	Strongly Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Strongly Agree

7. How often is information from current tests kept within your organization in order to compete for future test contracts?

0	1	2	3	4	5
No Response	Never	Rarely	Occasionally	Often	Always

8. How is the intent of keeping this information for future competition communicated?

0	1	2	3	4
No Response	Implicitly	Explicitly	Both	No information is kept for future competition

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